(12) UK Patent Application (19) GB (11) 2 315 937 (13) A

(43) Date of A Publication 11.02.1998

(21) Application No 9616143.5

(22) Date of Filing 01.08.1996

(71) Applicant(s)
Northern Telecom Limited

(Incorporated in Canada - Quebec)

World Trade Center of Montreal, 380 St Antoine Street West,8th Floor, Montreal, Quebec H2Y 3Y4, Canada

(72) Inventor(s)
Robin Paul Rickard

(74) Agent and/or Address for Service
Nortel Patents
London Road, HARLOW, Essex, CM17 9NA, United Kingdom

(51) INT CL^6
H04B 3/56

(52) UK CL (Edition P)
H3W WVX
U1S S2207

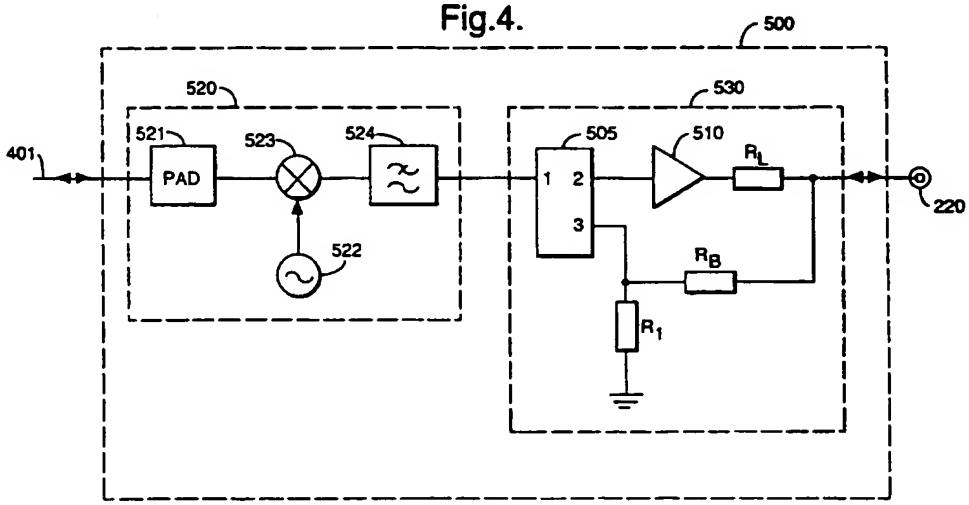
(56) Documents Cited
US 4529904 A

(58) Field of Search
UK CL (Edition O) H3W WVX
INT CL^6 H03F 3/00 3/181 , H04B 3/56
ONLINE:WPI

(54) TDMA power line communication transceiver using amplifier with reverse direction bypass

(57) An amplifier arrangement 530 for use in a time-division duplexed communications path 401 in which signals flow in first and second directions along the path during different time periods. The arrangement comprises an amplifier 510 for providing gain in the first direction of signal flow and a bypass path across the amplifier to enable signal flow in the second direction to bypass the amplifier.

Fig.4.



GB 2 315 937 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

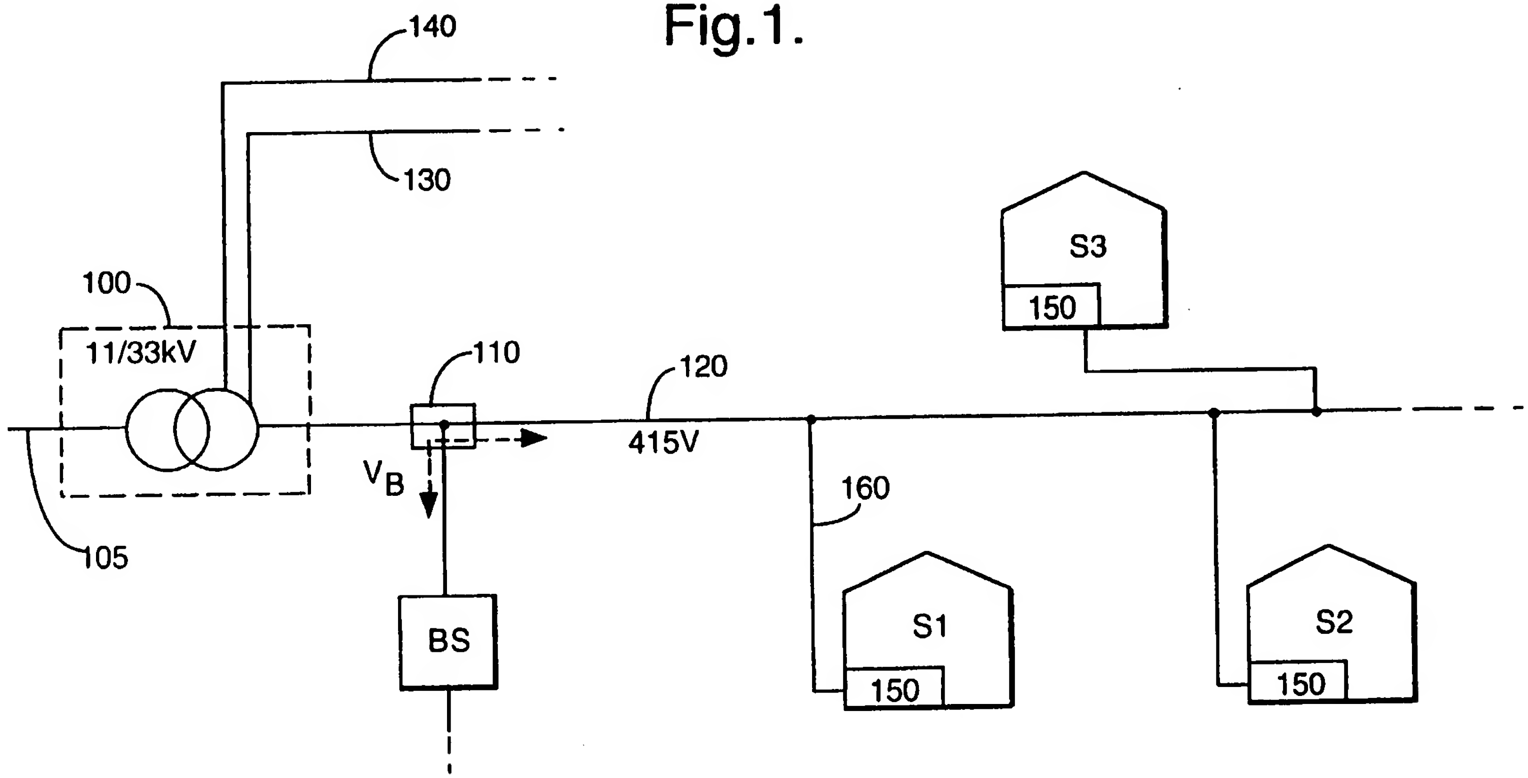

140
130
100
11/33kV
110
120
415V
V_B
105
BS
160
S1
150
S2
150
S3
150

Fig.2.

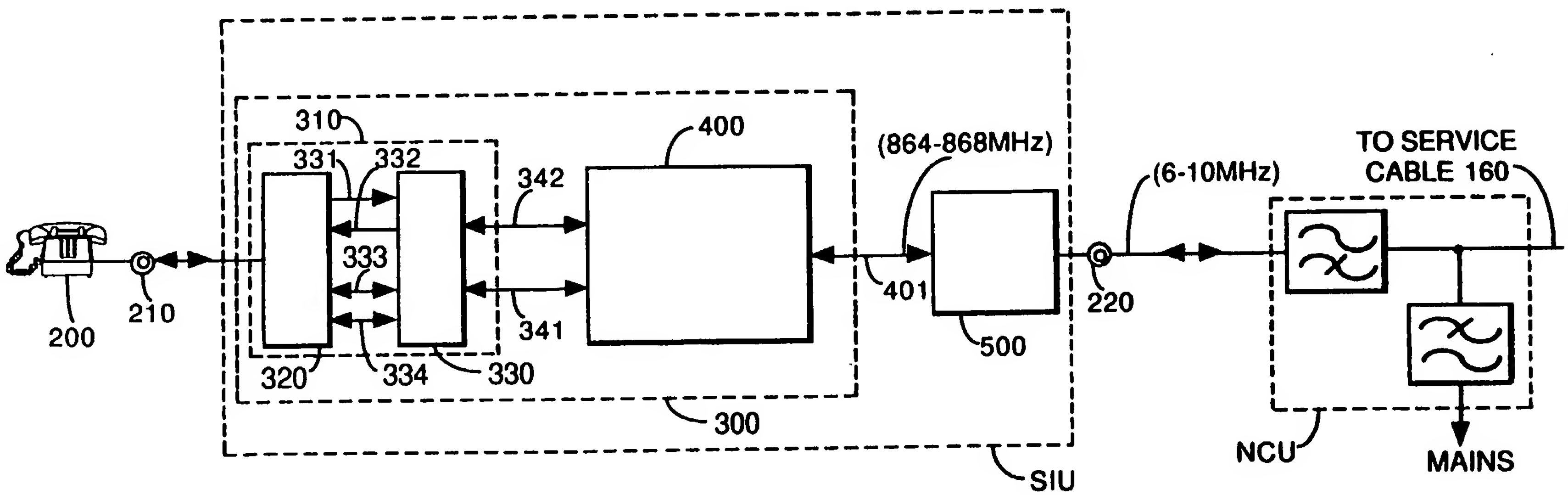
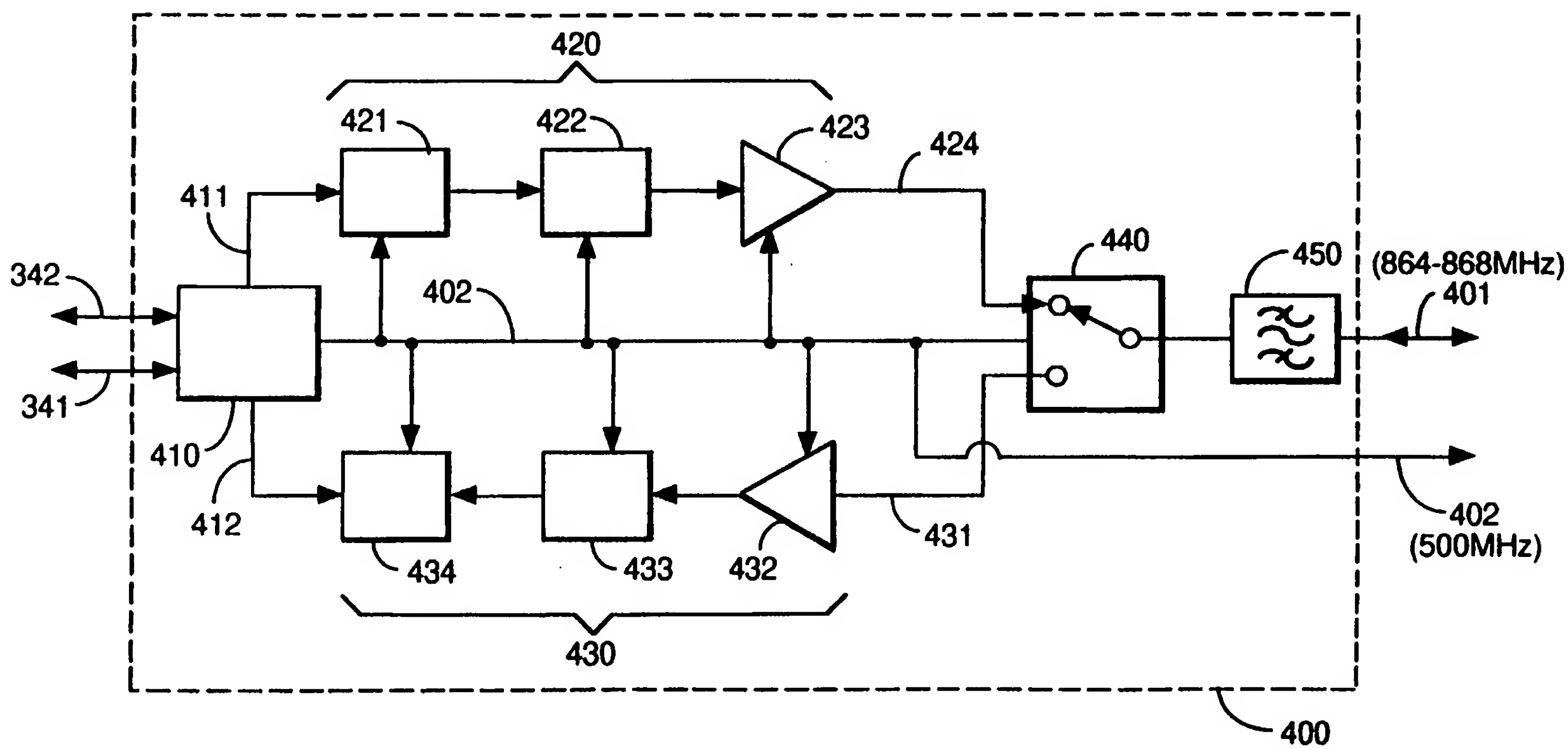

310
331
332
333
334
320
330
342
341
400
300
(864-868MHz)
401
500
SIU
200
210
220
(6-10MHz)
TO SERVICE
CABLE 160
NCU
MAINS

Fig.3.


420
421
422
423
424
411
440
450
(864-868MHz)
401
342
402
341
410
412
434
433
432
431
402
(500MHz)
430
400

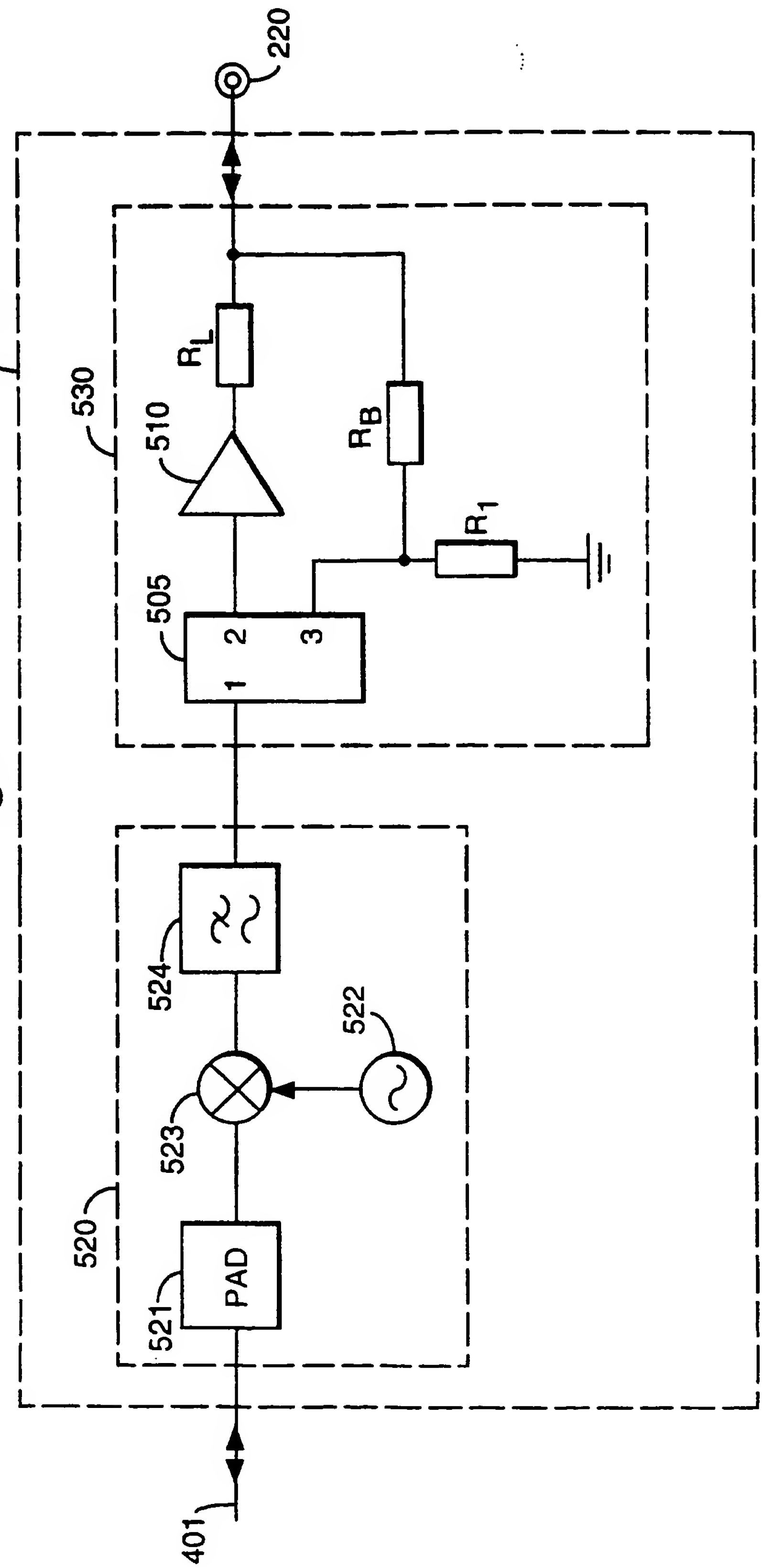


Fig.4.

Fig.5.

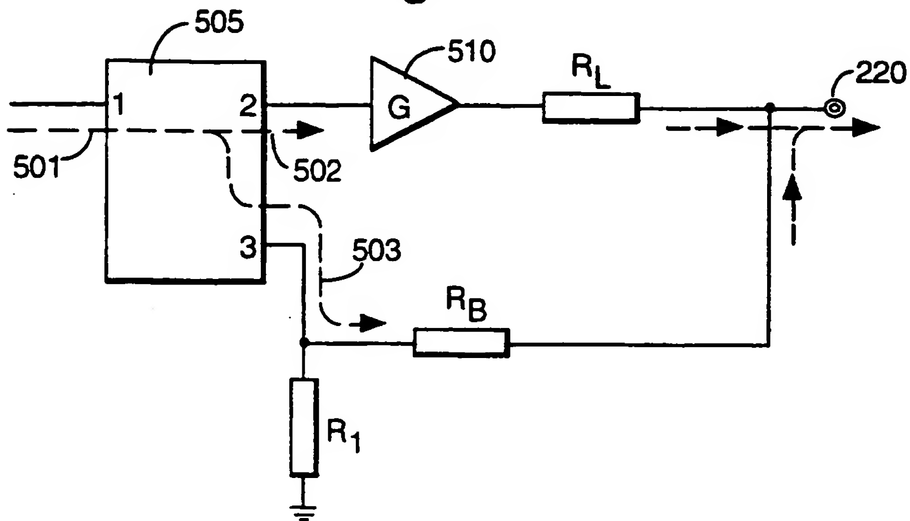
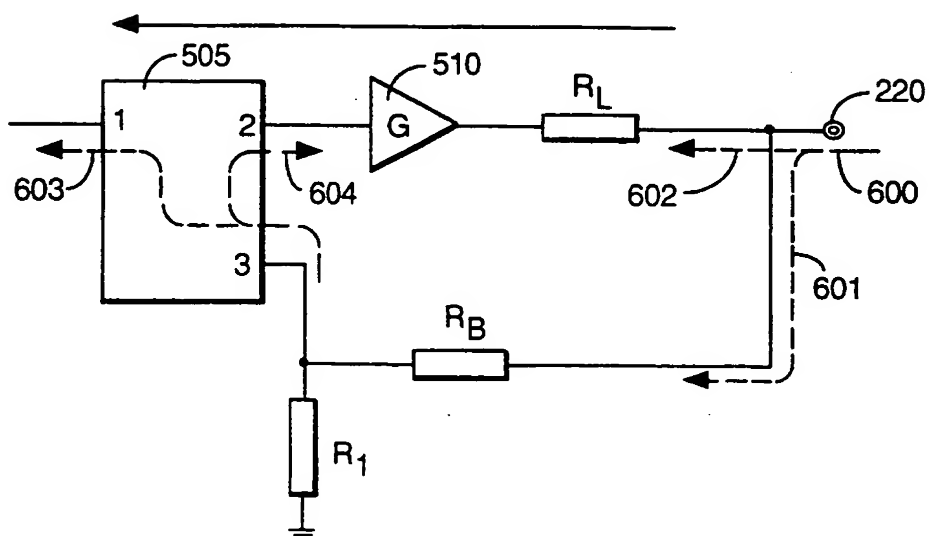

505
510
R_L
220
1
2
G
501
502
3
503
R_B
R_1

Fig.6.


505
510
R_L
220
1
2
G
603
604
602
600
3
601
R_B
R_1

2315937

COMMUNICATIONS TRANSCEIVER

This invention relates to an apparatus for use in a communications transceiver.

It is known to transport telecommunications signals over an electricity distribution or power transmission network. Patent Application WO 94/09572 A1 (Norweb) describes such a network. Delivering a telecommunications service in this manner is attractive as it overcomes one of the greatest costs in providing a new telecommunications network i.e. installing cabling to each subscriber. Existing electricity distribution cabling is used to carry the telecommunications signals.

Figure 1 shows an electricity distribution network which is adapted to carry telecommunications signals. Mains electricity enters the network from an 11kV transmission line 105 and is transformed by substation 100 into a 415V supply which is delivered over cable 120 to subscribers S1, S2, S3. A basestation BS couples telecommunications signals V_B, such as voice and data signals, at injection point 110 onto distribution cable 120. The telecommunications signals propagate over the cable on radio frequency carriers to transceiver units 150 at subscriber premises S1, S2, S3. In the upstream direction, telecommunications signals are transmitted from the subscriber transceiver units 150 towards the basestation over cable 120.

Equipment which has been developed for radio communications can, with modifications, be used at the basestation and transceiver units. Radio protocols such as CT2 and DECT are particularly attractive for use in mains communications systems.

Using existing radio equipment considerably reduces the cost of a transceiver unit. However, the output of a radio transceiver is at a frequency which is unacceptable for transmission over the electricity distribution network e.g. 864-868MHz for a CT2 set. Frequency conversion is required to a more suitable frequency band in the region of 1-20MHz, such as 2-6MHz. The need to perform frequency conversion means that full use cannot be made of the power amplifier in the output stage of the radio transceiver. This is because the mixer used in the subsequent frequency conversion stage requires a reasonably low level signal to avoid compression. Further amplification is needed after frequency conversion.

Patent Application WO 95/29537 (Norweb) describes an arrangement for use with a time-division duplex radio transceiver, which performs the above mentioned frequency conversion and amplification that is required for transmitting a TDD signal over a mains communication network. The described arrangement makes connections to the transmit and receive stages of the radio transceiver and performs frequency conversion and amplification in these separate paths. Each path has a mixer, amplifier and filter. The transmit and receive paths are combined by a transmit/receive switch into a single time-division duplex signal path. This is considered an expensive solution as it requires a number of additional components in addition to the radio transceiver. Furthermore, it has been found that additional amplification is only required in the upstream transmission direction.

The present invention seeks to provide a simplified time-division duplex communications equipment.

According to the present invention there is provided an amplifier arrangement for use in a time-division duplexed communications path in which signals flow in first and second directions along the path during different time periods, the arrangement comprising an amplifier for providing gain in the first direction of signal flow and a bypass path across the amplifier to enable signal flow in the second direction to bypass the amplifier.

It has been found that amplification is only required in the upstream direction of signal flow, from the subscriber towards the base station. The bypass path of this amplifier arrangement allows downstream signals to flow around the amplifier, and does not include an amplifier.

Preferably the amplifier arrangement includes means for limiting flow of signals from the bypass path into the input of the amplifier.

In one embodiment of the invention the limiting means comprises a switch which is operable to connect the amplifier to the communications path during the first direction of signal flow and the bypass path to the communications path during the second direction of signal flow.

In another embodiment of the invention the limiting means comprises a coupler for coupling signal flow in the first direction in the communications path to the amplifier and for coupling signal flow in the second direction to the bypass path.

In a further embodiment of the invention the limiting means comprises attenuation means in the bypass path.

Use of a coupler and/or an attenuation means as a means of limiting flow into the input of the amplifier avoids the use of a transmit/receive switch. This reduces power consumption of the equipment as it relies on passive components rather than an active one, and avoids the need to derive a timing signal for the switch.

According to another aspect of the invention there is provided a method of operating an amplifier arrangement for use in a time-division duplexed communications path in which signals flow in first and second directions along the path during different time periods, the method comprising providing gain in an amplifier in the first direction of signal flow and passing a signal through a bypass path across the amplifier in the second direction of signal flow.

The amplifier arrangement is best suited to systems where the wanted received signal is significantly above thermal noise. When transmitting telecommunications signals over electricity distribution networks the received signal is typically 80dB above thermal noise, and the main limitation on the received signal is high-level interfering signals.

For a better understanding of the invention, and to show by way of example how it may be carried into effect, embodiments will now be described with reference to the accompanying drawings, in which:

Figure 1 shows an electricity distribution network which is adapted to transport telecommunications signals;

Figure 2 shows equipment which is installed at a subscriber's premises in the network of figure 1;

Figure 3 shows a time-division duplex interface used in the equipment of figure 2;

Figure 4 shows a frequency conversion and amplification unit used in the equipment of figure 2;

Figures 5 and 6 show the unit of figure 4 in operation.

Figure 2 shows in more detail, the equipment 150 which is installed at a subscriber's premises for the telecommunications service.

A network conditioning unit NCU is connected between service cable 160 and subscriber terminal equipment 200. Network conditioning unit NCU is primarily for coupling telecommunications signals at the selected frequencies in the range 1MHz to 20MHz between telecommunications subscriber's apparatus and the mains supply cable 160, and for providing electrical isolation between this subscriber's apparatus and the voltage of the mains supply.

The subscriber's apparatus in the consumer's premises can include conventional public switched telephone network terminal equipment such as a telephone, facsimile machine or computer modem. The subscriber's apparatus also includes a subscriber's interface unit SIU,

connected between the terminal point 210 and the network conditioning unit NCU. The subscriber's interface unit SIU converts telecommunications signals between full duplex form and time division duplexform at a carrier frequency in the range 1MHz to 20MHz for coupling to the mains supply cable.

The subscriber's interface unit SIU comprises a first conversion device 300 for converting telecommunications signals between full duplex form at the telephone terminal point 210 and time-division duplex form at a carrier frequency in the band 864-868MHz and a second conversion device 500 for converting these signals to a carrier frequency in the range 1MHz to 20MHz and for amplifying the signals. All the circuits of the subscriber's interface unit SIU can be powered by a suitable d.c. voltage derived from the consumer's mains supply.

The first conversion device 300 includes a signal separation interface 310. This receives, at terminal point 210, telecommunications signals in duplex form which comprise user information (voice or data) and signalling information on a single path. These are converted to digital form, with the user information 341 and signalling information 342 on separate paths. The first conversion device 300 also includes a time-division duplex interface 400 for converting the telecommunications signals in the digital form with user information 341 and signalling information 342 on separate paths to telecommunications signals on a single path 401 in time-division duplex form with a predetermined digital format.

The signal separation interface device 310 will now be described in more detail with reference to Figure 2. This will be followed by a description of the detail of the time-division duplex interface 400 with reference to Figure 3 and then a description of the second conversion device 500 with reference to Figures 4 to 6.

The signal separation interface device 310 consists of a line card unit 320 and a processing unit 330. The full duplex signals at the telephone point 210 are analogue signals at audio frequencies on a single path.

The line card unit 320 is a commercially available circuit, similar in function to a conventional local exchange line circuit, which provides conversion between these analogue signals on a single path and the conventional components of these analogue signals on separate paths. These components are the three components of signalling information as the outgoing off-hook signal on path 331, the incoming ringing signal on path 332, and the outgoing multifrequency address signals on path 333, and also the two-way user information signals (voice or data) on path 334. The processing unit 330 includes analogue to digital conversion, digital to analogue conversion and a micro-processor function which together effect conversion between the user information (voice or data) in analogue form on path 334 and that user information in digital form on path 341, and also effect conversion between the off-hook, ringing and address signalling information in analogue form on paths 331, 332 and 333 and that signalling information in digital form combined on path 342 separate from path 341.

If the subscriber equipment is ISDN compatible, then the full duplex signals at the telephone point 210 will be digital user and signalling information signals on a single path and the signal separation interface means 310 will provide conversion between these digital signals at point 210 and the user information 341 and signalling information 342 in digital form on separate paths.

Referring now to Figure 3, the time division duplex interface device 400 will be described in detail.

Formatting/deformatting device 410, which may be implemented essentially by a microprocessor, interfaces with the digital user information and digital signalling information paths 341, 342 and provides the following three functions. Firstly it converts the digital user information 341 and the digital signalling information 342 into digital logical signals 411 in a predetermined time-division duplex format before modulation onto a carrier frequency. Secondly it converts digital logical signals 412 in this predetermined time-division duplex format after demodulation from this carrier frequency into the digital user information

341 and the digital signalling information 342. Thirdly it generates a time division duplex burst timing signal 402.

A transmission path 420 has a modulator 421, a frequency up-converter 422 and a power amplifier 423 which are controlled by the burst timing signal 402 and provide the time-division duplex formatted digital signals 411 modulated on to a carrier frequency in the band 864-868MHz. These are applied to a switch 440.

Switch 440 is controlled by burst timing signal 402 for conveying the telecommunications signals 424 from the transmit path 420 via bandpass filter 45 to the single path 401. The switch 440 also conveys telecommunications signals 431 modulated on to a carrier frequency in the band 864-868MHz from the single path 401 and the bandpass filter 450 in alternate time-division duplex burst periods to a reception path 430.

The reception path 430 has a low noise amplifier 432, a frequency down converter 433 and a demodulator 434 which are controlled by the burst timing signal 402 and provide the demodulated time division duplex formatted digital signals 412 to the formatting/deformatting means 410.

The above-mentioned time-division duplex format is in accordance with the digital cordless telephony CT2 standard. The CT2 standard operates with a 4MHz bandwidth divided into forty 100KHz wide channels each on carrier frequencies between 864MHz and 868MHz, and with a time-division duplex burst frequency of 500Hz. Channel selection and conversion to and from a particular carrier frequency in the 864MHz to 868MHz band is effected in the frequency up-converter 422 and in the frequency down-converter 433.

The time-division duplex interface device 400 is a standard unit as used in a radio handset. The output of this device is at 864-868MHz, which is too high for transmission over the electricity distribution network. Frequency conversion is required, to a suitable band and then amplification to a suitable level for injection onto the mains network.

Referring to figure 4, second conversion device 500 comprises a frequency converter 520 and an amplifier arrangement 530. Frequency converter 520 includes a mixer 523 and a local oscillator 522 which serve for frequency down-conversion and for frequency up-conversion in alternate time division duplex burst periods. An attenuator 521 is provided between the mixer 523 and path 401 to ensure a suitably low power level for operation of the mixer during frequency down conversion. A low pass filter 524 is provided on the other side of the mixer. The frequency converter provides conversion between telecommunications signals in CT2 time-division duplex format at a carrier frequency within the 4MHz band from 864MHz to 868MHz on the path 401 and these telecommunications signals in the same CT2 time-division duplex format at input/output port 220 where they are at a carrier frequency also within a 4MHz band but within the range for example 2 to 6MHz.

Amplifier arrangement 530 provides amplification of the frequency down-converted signal during the subscriber terminal transmit phase of a TDD cycle. One preferred embodiment of the amplifier arrangement is shown. A bypass path from output 220, through resistance R_B and directional coupler 505 allows the signal during the subscriber terminal receive phase of the TDD cycle to flow to frequency converter 520 for frequency up-conversion.

Amplifier arrangement 530 comprises a directional coupler 505, amplifier 510, load resistance R_L, and a potential divider comprising a bypass path resistance R_B and a further resistance R_1. The directional coupler has the following properties:

Port 1-2	3dB loss
Port 1-3	3dB loss
Port 2-3/3-2	isolation (typically 20dB loss or more)
Port 3-1	3dB loss

Load resistance R_L may be incorporated into amplifier 510. The purpose of this resistance is to prevent shorting of the output signal from the amplifier, and to prevent a signal entering from output 220 from shorting to ground rather than flowing through the bypass path. Resistance R_1 provides impedance matching for the directional coupler.

Figures 5 and 6 show the operation of the amplifier arrangement during transmit and receive phases of a time-division duplex (TDD) cycle. Firstly, figure 5 shows operation during the transmit phase of the TDD cycle. A signal 501 enters directional coupler 505 at port 1 and divides into two parts 502, 503. The first part 502 leaves port 2 of the coupler, is amplified by power amplifier 510, passes through the load resistance R_L and through output 220 towards the network. The second part 503 of input signal 501 leaves port 3 of the coupler, passes through bypass path resistance R_B and also flows towards the network. This second signal 503 is at a considerably lower level than the amplified signal 502 and has minimal effect when it combines with 502 at output 220.

Secondly, figure 6 shows operation of the amplifier arrangement during the receive phase of the TDD cycle. A signal 600 enters from the network. This divides into two parts 601, 602. The first part 602 flows into the potential divider arrangement of resistances R_B and R_1. This signal is tapped at the mid-point of R_B and R_1 and enters the directional coupler at port 3. This signal divides into the coupler into signals 603 and 604. The main output 603 flows towards the receiver. Signal 604 is heavily attenuated by the coupler. Signal 602 is dissipated in load resistance R_L.

Using one mixer, and one local oscillator for frequency down-conversion and for frequency up-conversion, together with one amplifier, is particularly advantageous for component costs and power consumption compared with using a separate frequency converter and amplifier for transmission and reception.

Amplifier 510 typically has a gain of 20-30dB. The attenuation, or loss, in the bypass path exceeds the gain in the amplifier stage. This is to

prevent the amplifier from oscillating. If the attenuation (loss) provided by the potential divider is greater than the amplifier gain, then the coupler can be omitted, and the bypass path can be joined directly to the input to the amplifier.

In an alternative embodiment the directional coupler is positioned at the output of the arrangement. This is less advantageous as port 1 of the coupler requires a particular matching impedance to operate correctly. Placing the coupler at the subscriber interface unit (SIU) end of the arrangement allows the impedance matching of port 1 of the coupler to be controlled.

In a further alternative embodiment the coupler can be replaced by a switch. This permits complete isolation of the bypass path (for use during the subscriber terminal receive phase) from the amplifier stage. This requires a switching signal 402 from the radio transceiver.

CLAIMS

1. An amplifier arrangement for use in a time-division duplexed communications path in which signals flow in first and second directions along the path during different time periods, the arrangement comprising an amplifier for providing gain in the first direction of signal flow and a bypass path across the amplifier to enable signal flow in the second direction to bypass the amplifier.

2. The arrangement of claim 1 further comprising means for limiting flow of signals from the bypass path into the input of the amplifier.

3. The arrangement of claim 2 wherein the limiting means comprises a switch which is operable to connect the amplifier to the communications path during the first direction of signal flow and the bypass path to the communications path during the second direction of signal flow.

4. The arrangement of claim 2 wherein the limiting means comprises a coupler for coupling signal flow in the first direction in the communications path to the amplifier and for coupling signal flow in the second direction to the bypass path.

5. The arrangement of claim 2 wherein the limiting means comprises attenuation means in the bypass path.

6. The arrangement of claim 1 wherein gain of the closed loop comprising the amplifier and the bypass path is less than one.

7. An arrangement according to claim 1 further comprising a frequency converter coupled to the input of the amplifier and to the bypass path for converting the frequency in both directions of signal flow.

8. A time-division duplex communications transceiver including an amplifier arrangement according to any preceding claim.

9. A communications transceiver comprising:

- a time-division duplex transceiver having a single output which carries a time-division duplex signal modulated onto an RF carrier in a first frequency band, and

- an amplifier arrangement according to any preceding claim, wherein the signal flow in the first direction comprises the modulated RF carrier in the first frequency band.

10. A subscriber terminal equipment for communicating over an electricity network, the equipment comprising a communications transceiver according to claim 9.

11. A method of operating an amplifier arrangement for use in a time-division duplexed communications path in which signals flow in first and second directions along the path during different time periods, the method comprising providing gain in an amplifier in the first direction of signal flow and passing a signal through a bypass path across the amplifier in the second direction of signal flow.

Application No: GB 9616143.5
Claims searched: 1-11

Examiner: David Midgley
Date of search: 30 October 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H3W (WVX)

Int Cl (Ed.6): H03F 3/00,3/181 H04B 3/56

Other: ONLINE:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 4529904 (International)	1,11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		